

Docket No. 303.658US1
WD # 474688

Micron Ref. No. 99-0591

CLEAN VERSION OF PENDING CLAIMS

COMBINED BARRIER LAYER AND SEED LAYER

Applicant: Dinesh Chopra

Serial No.: 09/838,493



RECEIVED
JAN 22 2003
TECHNOLOGY CENTER 2800

Claims 1-9, 11-14, 16-41, and 43-57, as of January 8, 2003 (Date of Response to First Office Action).

1. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer using a first electrolyte where the first electrolyte is the cation of the anode in an electrochemical reaction cell; and
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer using a second electrolyte.
2. The method of claim 1, wherein the dual-purpose layer comprises a material capable of reducing diffusion of the conductive interconnect material into surrounding materials, and wherein the dual-purpose layer comprises a material having a resistivity that allows electrochemical deposition of the conductive interconnect material.
3. The method of claim 1, wherein the dual-purpose layer comprises a material selected from the group consisting of tungsten, tungsten nitride, and tungsten-silicon nitride.
4. The method of claim 1, wherein the material comprising the dual-purpose layer comprises tungsten.
5. The method of claim 1, wherein the conductive interconnect material comprises copper.

6. The method of claim 1, wherein a voltage of at least about 0.1 V and not more than about 1 V is applied during both the electrochemically reducing step and the electrochemically depositing step for a time period of from about 30 seconds to about 5 minutes.
7. The method of claim 1, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 5 mA/cm² to about 25 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.
8. The method of claim 1, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 10 mA/cm² to about 15 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.
9. The method of claim 1, wherein a current of from about 0.5 amps to about 10 amps and having a current density of about 12 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.
-
11. (Once Amended) The method of claim 12, wherein the anode is formed from titanium or titanized platinum.
12. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer in an electrochemical reaction cell comprising an anode formed from a material that can be oxidized in the presence of the material comprising the dual-purpose layer;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer; and
wherein the electrochemical reaction cell contains a first electrolyte comprising the cation

of the material used to form the anode.

13. (Once Amended) The method of claim 12, wherein the anode comprises titanium and the first electrolyte comprises titanium trichloride, titanium sulfate, titanium bromide, titanium trichloride, titanium iodide, titanium fluoride, or mixtures thereof.

14. (Once Amended) The method of claim 13, wherein the first electrolyte comprises titanium trichloride or titanium sulfate.

16. (Once Amended) The method of claim 25, wherein the electrochemically reducing step is performed in a first electrochemical reaction cell and the electrochemically depositing step is performed in a second electrochemical reaction cell.

17. (Once Amended) The method of claim 25, wherein the electrochemically reducing step and the electrochemically depositing step are performed in a single electrochemical reaction cell.

18. (Once Amended) The method of claim 25, wherein the electrochemical reducing step is performed using a first anode and the electrochemical depositing step is performed using a second anode.

19. (Once Amended) The method of claim 25, wherein the electrochemical reducing step and the electrochemical depositing step are performed using a single anode.

20. (Once Amended) The method of claim 25, wherein the dual-purpose layer comprises a material selected from the group consisting of tungsten, tungsten nitride, and tungsten-silicon nitride.

B²
cont

21. (Once Amended) The method of claim 25, wherein the material comprising the dual-purpose layer comprises tungsten.
22. (Once Amended) The method of claim 25, wherein the conductive interconnect material comprises copper.
23. (Once Amended) The method of claim 25, wherein the first anode comprises a material that can be oxidized in the presence of the material comprising the dual-purpose layer.
24. (Once Amended) The method of claim 25, wherein the first anode is formed from titanium or titanized platinum, platinum, or copper.
25. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer utilizing a first electrolyte in an electrochemical bath having an anode and a cathode;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer utilizing a second electrolyte; and
wherein the first electrolyte contains the cationic species of the material comprising the first anode.
26. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer utilizing a first electrolyte;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer utilizing a second electrolyte; and

B²
cont

wherein the first electrolyte comprises titanium sulfate, titanium bromide, titanium trichloride, titanium iodide, titanium fluoride, copper sulfate, or mixtures thereof.

27. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer utilizing a first electrolyte in an electrochemical cell having an anode;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer utilizing a second electrolyte; and
wherein the first anode is formed from titanium and the first electrolyte is titanium chloride or titanium sulfate.

28. (Once Amended) The method of claim 25, wherein a voltage of at least about 0.1 V and not more than about 1 V is applied during both the electrochemically reducing step and the electrochemically depositing step for a time period of from about 30 seconds to about 5 minutes.

29. (Once Amended) The method of claim 25, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 5 mA/cm² to about 25 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

30. (Once Amended) The method of claim 25, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 10 mA/cm² to about 15 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

31. (Once Amended) The method of claim 25, wherein a current of from about 0.5 amps to about 10 amps and having a current density of about 12 mA/cm² is applied during both electrochemically reducing step and the electrochemically depositing step.

B cont

32. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer utilizing a first electrolyte;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer utilizing a second electrolyte; and
wherein the first electrolyte comprises:
the cation of the material from which the conductive interconnect layer is made;
a complexing agent; and
a pH control agent.

33. The method of claim 32, wherein the conductive interconnect layer comprises copper and the electrolyte comprises copper sulfate.

34. The method of claim 32, wherein the complexing agent is selected from the group consisting of ethylene diamine tetra acetate, boric acid, and malonic acid.

35. The method of claim 32, wherein the complexing agent is ethylene diamine tetra acetate.

36. The method of claim 32, wherein the pH control agent is tetramethyl ammonium hydroxide, ammonium hydroxide, or potassium hydroxide.

37. The method of claim 32, wherein the pH control agent is tetramethyl ammonium

hydroxide.

38. The method of claim 32, wherein the electrolyte exhibits a pH greater than about 7.

39. The method of claim 32, wherein the electrolyte exhibits a pH greater than or equal to about 10.

40. The method of claim 32, wherein the electrolyte exhibits a pH greater than about 7 and less than or equal to about 12.

41. The method of claim 32, wherein the electrolyte exhibits a pH greater than about 10 and less than or equal to about 12.

43. (Once Amended) The method of claim 44, wherein the dual-purpose layer comprises tungsten.

3.
B 44. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer, wherein both the electrochemically reducing step and the electrochemically depositing step are performed in a single electrochemical reaction cell utilizing a single electrolyte;

wherein the electrolyte comprises:

the cation of the material from which the conductive interconnect material is made;

a complexing agent; and

a pH control agent.

3
B₃ cont

45. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer, wherein both the electrochemically reducing step and the electrochemically depositing step are performed in a single electrochemical reaction cell utilizing a single electrolyte;
wherein the electrolyte comprises:
the cation of the material from which the conductive interconnect material is made;
a complexing agent; and
a pH control agent; and
wherein the conductive interconnect material comprises copper and the electrolyte comprises copper sulfate.

46. The method of claim 44, wherein the complexing agent is selected from the group consisting of ethylene diamine tetra acetate, boric acid, and malonic acid.

4
B₄

47. (Once Amended) A method of metallizing a substrate, comprising:
depositing a dual-purpose layer on the substrate;
electrochemically reducing oxides on the surface of the dual-purpose layer;
electrochemically depositing a conductive interconnect layer on the surface of the dual-purpose layer, wherein both the electrochemically reducing step and the electrochemically depositing step are performed in a single electrochemical reaction cell utilizing a single electrolyte;
wherein the electrolyte comprises:
the cation of the material from which the conductive interconnect material is made;
a complexing agent; and

PENDING CLAIMS

Docket No. 303.658US1

Micron Ref. No. 99-0591

Page 9

B⁴
cont a pH control agent; and

wherein the complexing agent is ethylene diamine tetra acetate.

48. The method of claim 44, wherein the pH control agent is tetramethyl ammonium hydroxide, ammonium hydroxide, or potassium hydroxide.
49. The method of claim 44, wherein the pH control agent is tetramethyl ammonium hydroxide.
50. The method of claim 44, wherein the electrolyte exhibits a pH greater than about 7.
51. The method of claim 44, wherein the electrolyte exhibits a pH greater than or equal to about 10.
52. The method of claim 44, wherein the electrolyte exhibits a pH greater than about 7 and less than or equal to about 12.
53. The method of claim 44, wherein the electrolyte exhibits a pH greater than about 10 and less than or equal to about 12.

B⁵
54. (Once Amended) The method of claim 44, wherein a voltage of at least about 0.1 V and not more than about 1 V is applied during both the electrochemically reducing step and the electrochemically depositing step for a time period of from about 30 seconds to about 5 minutes.

55. (Once Amended) The method of claim 44, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 5 mA/cm² to about 25 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing

PENDING CLAIMS

Docket No. 303.658US1

Micron Ref. No. 99-0591

Page 10

step.

5
By
cont

56. (Once Amended) The method of claim 44, wherein a current of from about 0.5 amps to about 10 amps and having a current density of from about 10 mA/cm² to about 15 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.

57. (Once Amended) The method of claim 44, wherein a current of from about 0.5 amps to about 10 amps and having a current density of about 12 mA/cm² is applied during both the electrochemically reducing step and the electrochemically depositing step.
